Myxomycetes and Dictyostelids as Biological Indicators

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INTRODUCTION

The myxomycetes (plasmodial slime molds, Fig. 1) and dictyostelids (cellular slime molds, Fig. 2) are two groups of microscopic protists that belong to the taxonomic assemblage known as the eumycetozoans. Members of both groups are normal components of the soil microflora. During the amoebal stage, they meet their nutritional needs by feeding primarily on the bacteria found within the microhabitats where they occur. Both groups are capable of producing large populations in soils. Ultimately, myxomycetes and dictyostelids propagate themselves by forming fruiting bodies that superficially resemble those produced by certain fungi; these fruiting bodies contain spores. There are some similarities as well as fundamental differences between the life cycles of these organisms (Figs. 3 and 4). Slime molds have been documented from virtually all terrestrial ecosystems. Collectively, they seem especially well suited to serve as biological indicators for assessing differences in the soil microbial system among various study sites.

JUSTIFICATION

Myxomycetes and dictyostelids have been documented to occur in virtually all types of terrestrial ecosystems, ranging from forests (Stephenson, 1988) to grasslands (Rollins et al., in press), and extend geographically from the Polar Regions to the tropics, wherever detritus (i.e., dead and decaying plant material) is present. These organisms apparently play a major role in maintaining the ecological balance that exists between bacteria and other soil organisms. In fact, small amounts (1 cm^3) of soil can contain as many as 20,000 individual myxomycete cells (Feest, 1987). This suggests that myxomycetes are important in nutrient cycling as members of the detritus food chain. Myxomycetes and dictyostelids seem especially well suited to serve as biological indicators for assessing the fundamental differences that exist for the soil microbial system among selected study sites (Landolt et al., 1992).

PROOF OF CONCEPT

Cavender et al. (1993) reported the recovery of dictyostelids following slash and burn practices in the tropics. Landolt and Stephenson (1995) documented the effects of Diflubenzuron on these organisms in the upland forests of West Virginia. In the grasslands of the mid-western United States, we have documented the responses of these organisms to different grazing and burning regimes (Rollins et al., in press). In addition, we have documented correlations between the densities of these organisms and various soil parameters (i.e., aluminum, boron, calcium, copper, iron, and phosphorous). The feasibility of utilizing myxomycetes to assess the accumulation of heavy metals in the environment has been tested successfully (e.g., McQuattie and Stephenson, 2000; Stephenson and McQuattie, 2000). In fact, some species have been reported to tolerate incredibly high levels of heavy metal accumulation. For example, *Fuligo septica*, a myxomycete (Fig. 5), has been reported to bioaccumulate zinc and survive at extremely high levels of concentration (4,000 to 20,000 ppm) (Setala and Nuorteva, 1989; Zhulidov et al., 2002). Both the biodiversity and relative abundance of the myxomycetes and dictyostelids are relatively easy to determine using relatively simple field and laboratory protocols.

Fig. 1 The myxomycete *Diachea leucopodia*

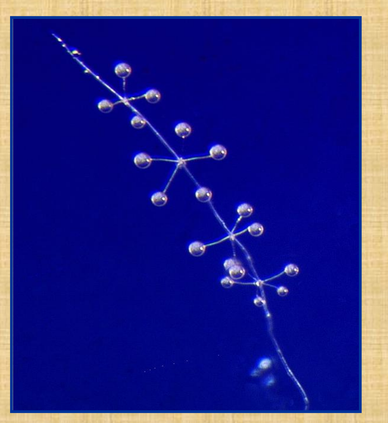

Fig. 2 The dictyostelid *Polysphondylium pallidum*.

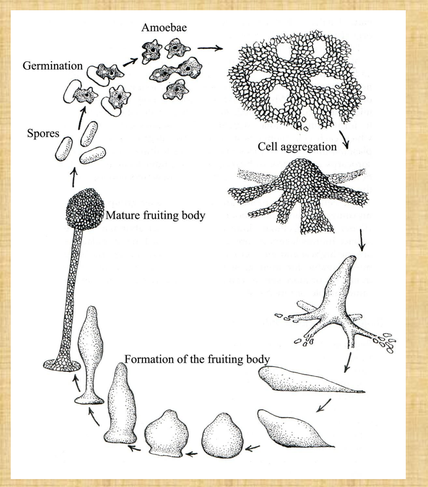

Fig. 3 The dictyostelid life cycle.

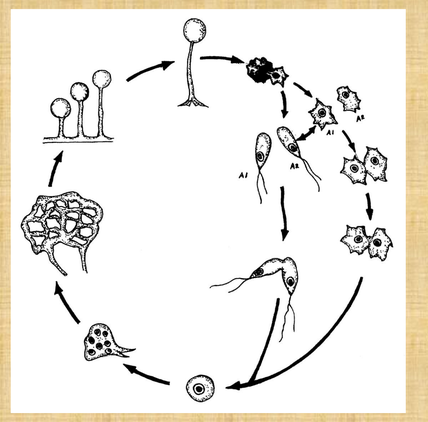

Fig. 4 The myxomycete life cycle.

Fig. 5 The myxomycete, *Fuligo septica*.

POTENTIAL METHODOLOGIES

A series of monitoring plots (e.g., 10 m x 10 m) would be established in an affected area (e.g., the 2008 Kingston fly ash spill site) and adjacent unaffected sites. The sites would be inspected for the presence of fruiting bodies that developed under natural conditions in the field. In addition samples of soil and decaying vegetation would be collected and transported to the laboratory, where the samples would be subjected to cultural methods directed at each group in order to isolate the myxomycetes and dictyostelids present within each sample. Collectively, the fruiting bodies (field collected and isolated in the laboratory) would be subjected to analysis utilizing atomic absorption spectrophotometery to determine the concentrations of key analytes of interest.

SIGNIFICANCE / OUTCOMES

A study as described herein would generate a body of novel information relating to the ecological effects of targeted analytes on terrestrial microbial community dynamics. Second, this type of data would allow us to assess the function of myxomycetes and dictyostelids with respect to their potential to uptake targeted analytes directly from the soil microhabitat. Furthermore, these studies could contribute to the understanding of the effects of targeted analytes and their movement through communities (analyte → soil →bacterium → slime mold → terrestrial snail → bird → fox). Ultimately, a better understanding of this entire system could lead to the development of methodologies utilizing myxomycetes and dictyostelids to assess remediation efforts at spill sites. In addition, these methods could be used to monitor the conditions associated with various storage operations such as the leeching of selected analytes (e.g., from fly ash buried in landfills).

LITERATURE CITED

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